

Foot Reaction Forces During Spaceflight (FOOT)

Principal Investigator: Peter Cavanagh, Ph.D., The Cleveland Clinic Foundation, Cleveland

Overview

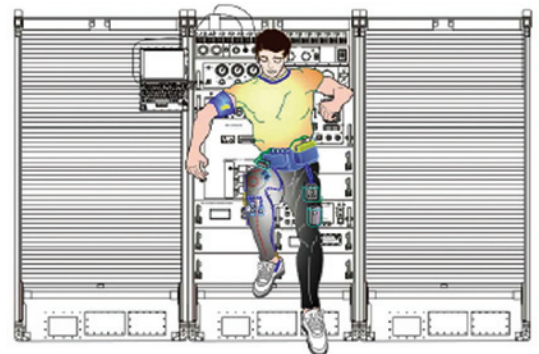
Without appropriate countermeasures, astronauts traveling in space can lose as much bone mineral in the lower extremities in one month as a typical post-menopausal woman loses in an entire year. Muscle strength can also be lost rapidly during spaceflight. Such decrements as a result of prolonged exposure to microgravity have important implications for performance and safety during space missions and thus the identification of mechanisms and countermeasures for such changes are a high priority for NASA.

It is widely believed that changes in bone and muscle are directly related to the decrease in mechanical loading. This hypothesis is supported by the fact that little or no bone mineral is usually lost from the upper extremities—which may be used even more frequently in orbit than they are on the ground. The objective of the experiment called FOOT is to quantify and explore the relationship between loading of the human body and changes in the musculoskeletal system during spaceflight. NASA fuels discoveries that make the world smarter, healthier and safer.

Experiment Operations

FOOT will accomplish its objective through direct measurement of forces on the feet, joint angles and muscle activity in astronauts during typical entire days of daily life both on earth and on the Space Station. In addition, bone mineral density, muscle strength and muscle volume will be measured before and after the mission.

The heart of the FOOT experiment is an instrumented suit called the Lower Extremity Monitoring Suit (LEMS). This customized garment is a pair of Lycra cycling tights incorporating 20 carefully placed sensors and the associated wiring, control units and amplifiers. LEMS will enable the electrical activity of muscles, the angular motions of the hip, knee and ankle joints, and the force on both feet to be measured continuously. Information from the sensors can be recorded for up to 14 hours on a small wearable computer. Measurements will also be made of the arm muscles. The crewmembers will put the suit on in the morning before they start their work day and, after calibration, they will go about their regular daily activities. Throughout the day, the sensors will capture data that will allow researchers to characterize differences between use of the arms and legs on Earth and in space.



Artist's impression of the LEMS

Before launch and after landing, DXA scans, MRIs and Cybex testing will be used to measure the changes in bone mineral density, muscle volume and muscle strength, respectively. Researchers will relate these changes to the measurements made from the LEMS.

Expedition 11 marks the third time FOOT will be performed in flight. FOOT was previously done on Expeditions 6 and 8.

Benefits

FOOT has the potential to shed significant new light on the reasons for bone and muscle loss during spaceflight and on the design

of exercise countermeasures. The data should allow the “dose” of mechanical load to be chosen based on the measurements performed in the study. Ideally, exercise countermeasures should replace the critical mechanical input that is present on Earth but missing in space. The Space Station environment offers an ideal setting in which the experimental hypothesis can be examined. In addition, the theories that are to be explored in this project have significance for understanding, preventing and treating osteoporosis on Earth, which is a major public health problem.

For more information, visit <http://www.nasa.gov>.

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